Turning Goals Into Reality

Propulsion Systems Contribution to the Future

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Rolls-Royce is…Building the Future Now

New Defense Programs

- STOVL JSF
- F136 for JSF
- Eurofighter
- AH-66 Comanche
- V-22 Osprey
- RQ-4A Global Hawk
- Fire Scout
- C-130J
- A400M
- Super Lynx 300

Technology Programs

- IHPTET
- VAATE
- SHFE
- SATE
- Joint US/UK HCF
- LRSA
- NAI
- UEET

Emerging Opportunities

- UCAR
- CRW

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Preparing for the Future: Near-term

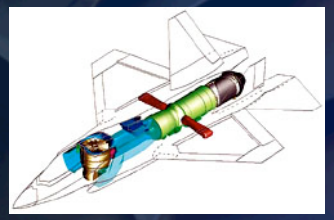
Platforms: Requirements:*Challenges*

V-22: convertible rotorcraft: *SFC, systems integration*

ERJ-145: low cost: *supply chain, environment*

Global Hawk: HALE: *SFC, Re, HPX*

JSF: stealth, STOVL, supercruise: *SFC, lift system integration*



Propulsion Enablers

- **Innovative architectures**
- **Efficient engines**
- **Power transmissions**
- **US Government funded advanced technology programs:**
  - DOD: IHPTET
  - NASA: AST & QAT
  - US/UK ASTOVL
- **Commonality with commercial systems**

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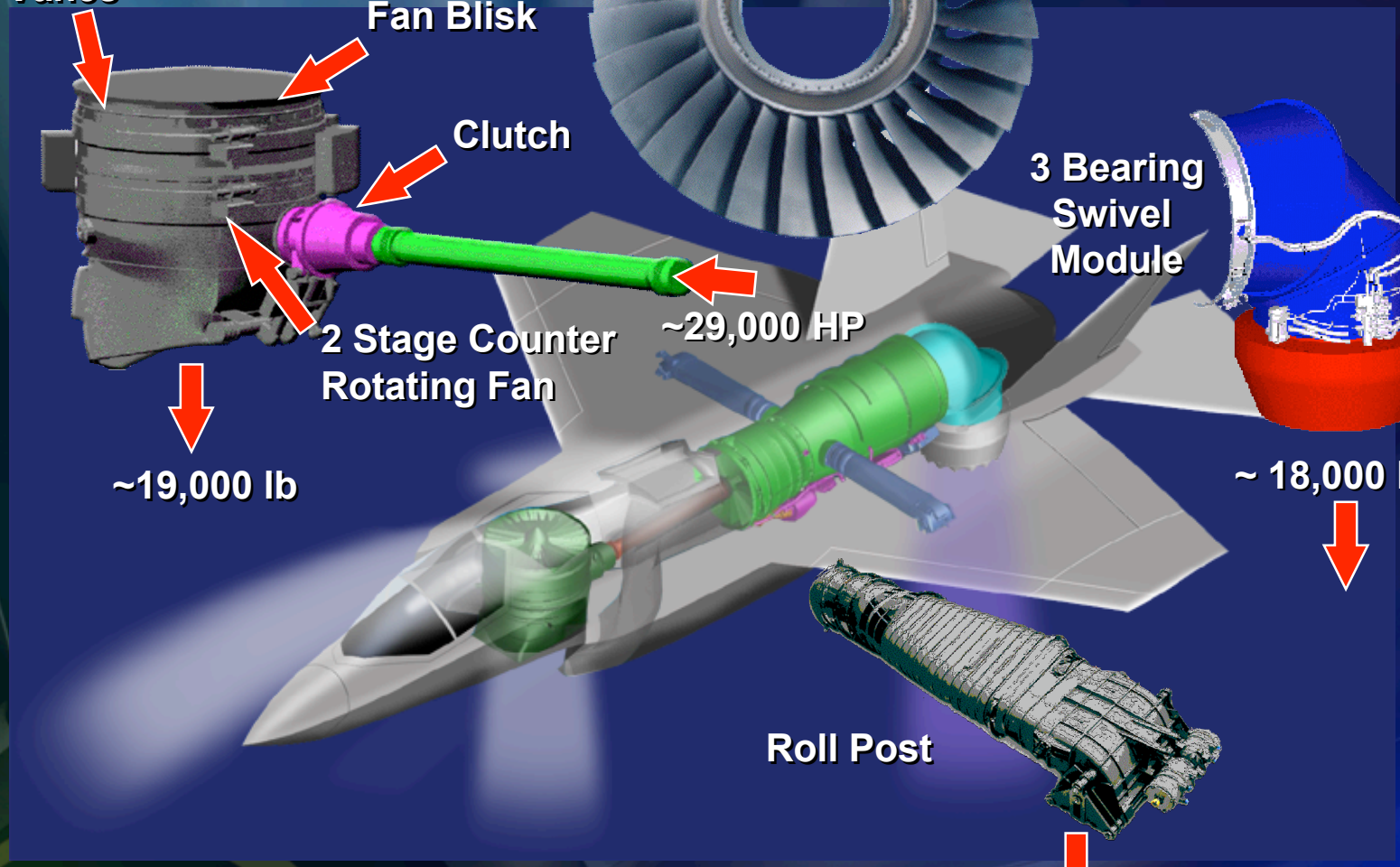
JSF Lift System



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Laying the Foundation for the Future: Medium-term (2010-2020)

Platforms: Requirements:*Challenges*

UCAV: range, stealth, endurance: *SFC, cost*

Mobility: high thrust, range: *SFC, cost*

Supersonic: speed, economics, environment: *cycle, cost*

Strike: speed, stealth, endurance: *cycle, cost*

Propulsion Enablers

- **High OPR, temperature**
- **Variable cycles**
  - Performance
  - Emissions
  - Noise
- **More electric engines**
  - High power extraction
  - Lubrication free
  - Magnetically suspended & controlled rotors
  - Prognostics & diagnostics
- **Government funded advanced technology programs:**
  - IHPTET, VAATE, QAT, UEET, NAI

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VAATE Focus Areas

Versatile Core

Military/Civil Multi-Use, Maintenance Friendly

- Wide Flow / High Efficiency Components
- Long Life for Safety & Design Margin
- High Excess Horsepower Technology

Durability

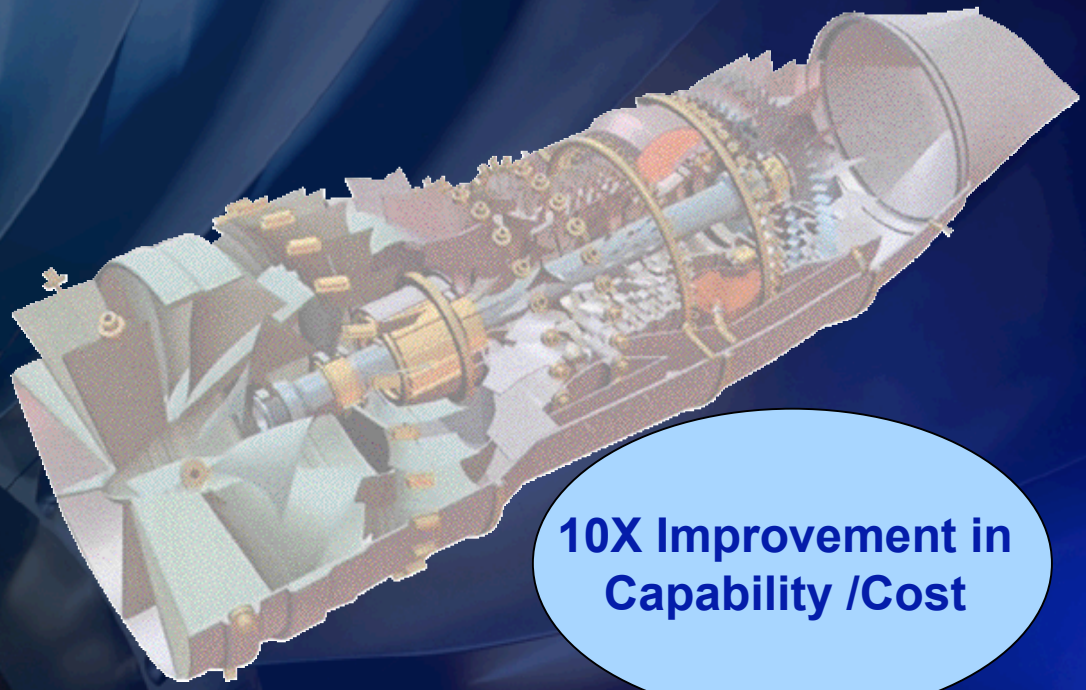
Turbine Engine Readiness

- Physics-Based Predictive Systems
- Integrated Inspection/Repair/Mfg & Materials Systems
- Robust, Damage Tolerance for Multi-Use Application
- Holistic Test Protocol & Accelerated Severity Testing

Intelligent Engine

High Performing, Adaptive

- Adaptive Component Performance
- Integrated Propulsion & Power
- Real Time Life Tracking
- Proactive Health Management



10X Improvement in Capability /Cost

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Electric Engine Concepts

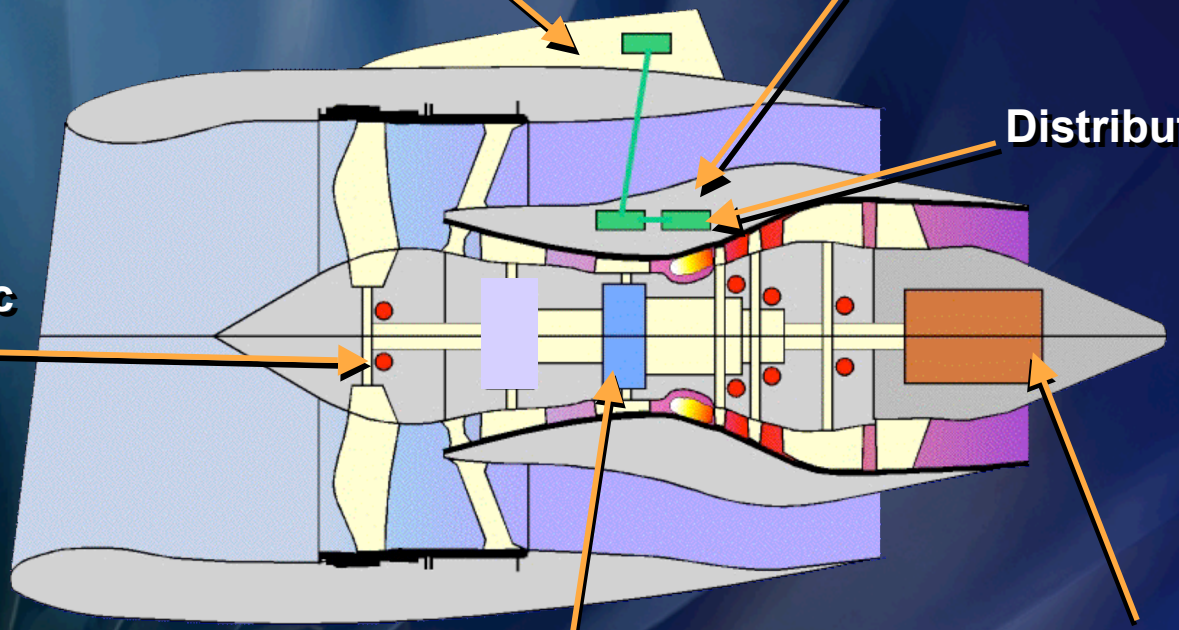
Aircraft/engine interface simplified to fuel, electricity and thrust

Intelligent sensors
Advanced engine health monitoring

All engine accessories electrically driven

Distributed controls

Active magnetic bearings



Air for pressurization/cabin conditioning supplied by dedicated electrical system

Internal starter motor/generator replaces conventional gearboxes

Generator on fan shaft provides power to airframe under both normal and emergency conditions

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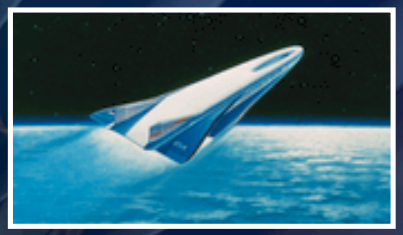
Anticipating the Future: Far-term

Platforms: Requirements:*Challenges*

Extended Endurance UAVs: continuous surveillance & communications: *closed cycles, systems integration*

Global Transport (trans-atmospheric): speed, cost: *cycle, cost*

Access to Space: speed, cost: *cycle, materials*



Propulsion Enablers

- **Novel cycles**
  - TBCC
  - Pulse detonation
  - Fuel cells
- **New fuels**
  - Endothermic, hydrogen, nuclear, solar
- **High temperatures and thermal integration**
- **Government funded advanced technology programs:**
  - VAATE, NAI

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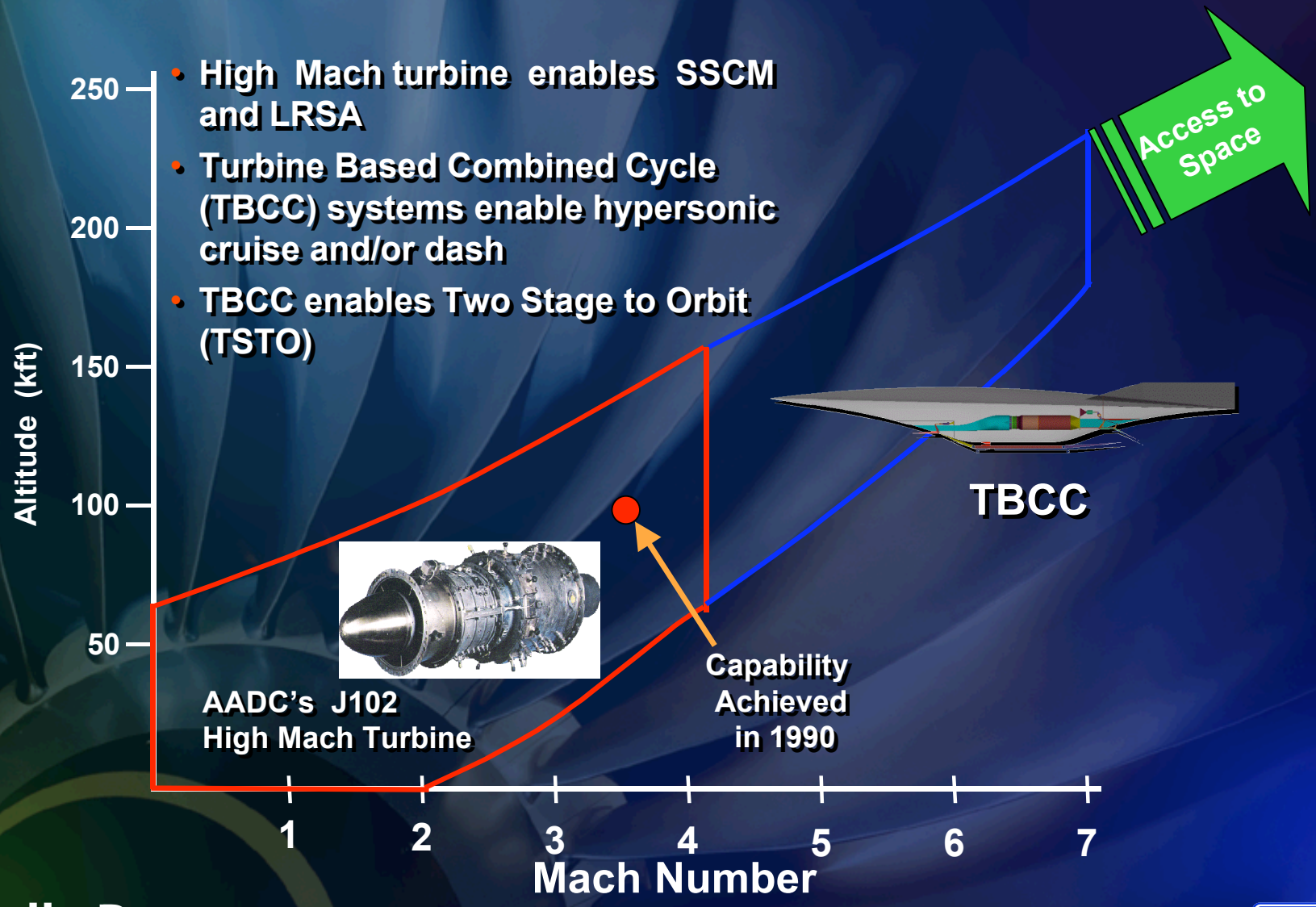
High Mach Turbine Engine Technology

- High Mach turbine enables SSCM and LRSA
- Turbine Based Combined Cycle (TBCC) systems enable hypersonic cruise and/or dash
- TBCC enables Two Stage to Orbit (TSTO)



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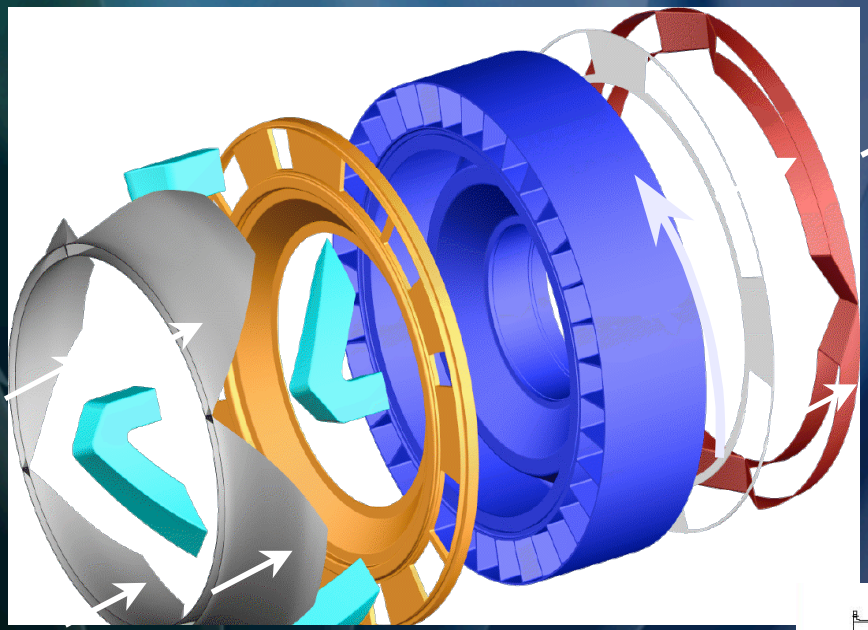
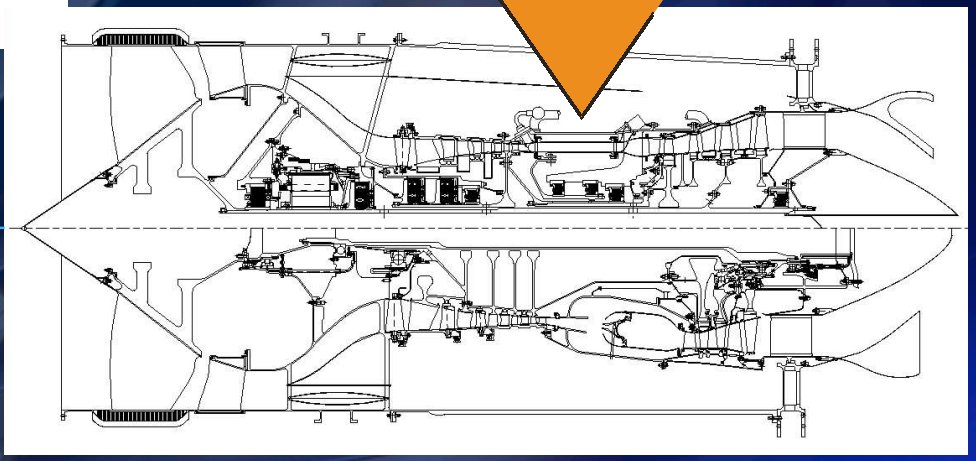
Constant Volume Combustor



Exploded View

CVC

Conventional



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Propulsion is Enabling the Future!

- Propulsion innovation and platform advances are inextricably linked
- Technology enablers have typically been developed by government programs and are pulled by advanced military requirements
- The time scale of propulsion technology is typically more than 20 years from early component demonstrations to first flight
- New requirements drive certain technologies, but most step changes come from synergistic combination of several enabling technologies
- Many propulsion technologies, novel cycles and new architectures are being developed today that will enable major steps in future systems

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Rolls-Royce Innovation: Delivering the Future

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